Guidelines...

Pruning White Pine in the Lake States for Blister Rust Control

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GUIDELINES: PRUNING WHITE PINE IN THE LAKE STATES FOR BLISTER RUST CONTROL

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ABSTRACT

Pruning white pine as one method of blister rust control has been practiced in the Lake States for nearly a decade. The guidelines in this report were developed to make the program more practical and to make it consistent throughout the Lake States. These guidelines include: minimum white pine stocking, minimum acreage, minimum annual lethal infection, minimum non-weeviled trees per acre, maximum number of trees per acre to be pruned and height of pruning.

INTRODUCTION

The presence of white pine blister rust (Cronartium ribicola Fischer) has been known in the Lake States since 1915; Wisconsin - 1915, Minnesota - 1916, Michigan - 1917 (Kroeber, 1948). Control practices have been administered in these states for approximately 40 years; the first 30 years of which was eradication of the alternate host, Ribes. In 1963, white pine pruning, sometimes referred to as pathological pruning, was incorporated into the blister rust control program. In the Lake States, this control method consists of pruning the lower limbs of white pine to a predetermined height in order to: (1) eliminate visible lethal infections 1/, (2) eliminate branches with incipient infections, and (3) reduce the target area for future infection. Instigation of this practice was due, primarily, to communication between S. Daryl Adams, U.S. Forest Service, and blister rust personnel associated with state organizations and National Forests within the Lake States. (Adams, 1967a; Adams, 1967b; Robert, 1966; Michigan Department of Agriculture, 1969).

The somewhat inconsistent and incomplete guidelines in this correspondence, and a short segment in the Forest Service Manual which reads: "Cutting off infected limbs will save a white pine tree, if no canker has reached the main stem;" (Section 5274.31) constitute the entire pruning rules in the Lake States to the present.

In 1970 and 1971, blister rust control personnel from the Michigan, Wisconsin and Minnesota Departments of Agriculture and from the St. Paul S&PF Field Office, USDA, held workshops to discuss, plan and evaluate pruning. A primary purpose for the resulting information was to establish consistent and more complete pruning guidelines for the Lake States. Information obtained from those workshops, from the pruning evaluation conducted by workshop personnel, and from literature cited, is the primary basis for the guidelines in this report.

1/ See Glossary, page 10, for definition of terms used in the text.

RESEARCH BACKGROUND

In 1955, Licke completed a pruning study in Minnesota where 25,000 white pine, planted in 1941, were examined. Sixty-six percent of the trees were healthy; 34 percent were infected with blister rust. By pruning to one-half the total tree height, 52 percent of the infected trees were saved. Forty-three percent of the infected white pine were non-prunable because of trunk cankers (Licke, 1956, Putnam, 1956).

Another Minnesota study involved pruned and unpruned plots established in a 20 year old, 44 acre white pine stand averaging 106 healthy and 114 infected trees per acre. One plot was treated by "pathological pruning, removal of diseased limbs only" from selected crop trees; two plots were treated by "a combination of pathological and silvicultural pruning, removal of all lower branches and those with cankers in the upper-whorls." In one of these two plots, all trees were pruned; in the other, only selected crop trees were pruned. A fourth plot was unpruned. Results after six years showed that 54 percent of the white pine in the unpruned plot had died; 33 percent had died in the pathological pruned plot; 23 percent died in the pathological-silvicultural all trees plot; 22 percent died in the pathological-silvicultural crop trees plot (Stewart, 1957).

In a survey report on the incidence of blister rust in the Lake States, it is estimated that about one-third of 1913 infected pines could have been saved by pruning off the infected limbs (King, 1958).

In a 1952 pruning experiment on the Nicolet National Forest, limbs from the lower four feet of 200 selected crop trees per acre were pruned. The trees were 14 years old and approximately 10 feet high. Twelve years after the pruning, 1478 trees were examined with the following results: 29.7 percent of the unpruned trees were fatally infected with blister rust; 13.4 percent of the pruned trees were fatally infected, thus there were more than twice as many fatally infected trees in the unpruned plots (Weber, 1964b). This study ended with practically no potential crop trees because of weevil damage and other stem-deforming factors (Weber, 1972).

A pruning study by Weber, where lower branch pruning was done biennially in a young white pine plantation, reduced lethal infection from 59 percent to 19 percent after five years. After ten years, the reduction was from 70 to 22 percent. Results of a similar study evaluated for six years show a reduction of fatal infection from seven to one percent.

Reduction is based on lethally infected unpruned trees vs. lethally infected pruned trees (Weber, 1964a; Weber, 1968).

In a 1971 evaluation of pruning in the Lake States, 3440 trees, 10 to 30 years old, pruned five to seven years prior to the evaluation, were examined. Four and two-tenths percent were infected with blister rust. Seven and one-half percent of 4326 unpruned trees of the same age class were infected (Brown, 1971).

Additional literature suggests pruning as a control method, but without substantiating research data. Boyce (1961) states that "in the eastern white pine region, management operations such as weeding, thinning and pruning in young stands, which increase either the quantity or,more particularly, the quality of timber, should be coordinated with disease-control practices." A Wisconsin Department of Agriculture and U.S. Forest Service brochure (1966) suggests the pruning of infected limbs on high-value white pine. Martin and Gravatt (1954), in a publication dealing primarily with pruning, recommend infected limb pruning and cutting out diseased parts from the main stem as control measures. Van Arsdel (1961b) includes "eradication of established cankers by pruning" with ribes eradication, disease resistant trees and antibiotics as blister rust control measures. Van Arsdel (1968a) recommends pruning or ribes eradication along with selective planting as control measures in moderate hazard areas; for high hazard areas he recommends pruning, eradication and selective planting.

PRUNING GUIDELINES

The above mentioned pruning studies and evaluations illustrate the biological value of pruning to increase the number of healthy white pine. However, there are no thorough pruning guidelines. To prune 500 white pine per acre in a stand that has one percent blister rust infection would probably save a few trees, but it would be impractical. The following are the Forest Service recommended guidelines for pruning white pine as a method of reducing blister rust infection in the Lake States. These guidelines, which are primarily for timber production, should be followed where federal funds are involved in blister rust control work, and are suggested when federal funds are not involved:

1) Each stand considered for pruning must have at least 200 prunable and non-weeviled white pine per acre.

2) Each white pine stand must be at least five acres in size.

3) Minimum annual lethal infection (based on the last five readable years when possible, i.e., except in stands younger than eight years) must be one percent or more.

4) Annual infection rate (percentage) will be based on the number of trees with lethal infections, not the total number of lethal or all infections.

5) The first infection survey should be made as soon as the average white pine age is four years and the average white pine height is two feet.

6) The maximum number of selected crop trees per acre pruned will be 200 for natural stands and 350 for plantations.

7) White pine should be pruned to 50 percent of the total height or nine feet, whichever is less.

8) All limbs with lethal infections above the normal pruning height, that are easily accessible, should be pruned.

Explanations for the guidelines are as follows:

1) Each stand considered for pruning must have at least 200 prunable and non-weeviled white pine per acre. Most management guidelines suggest a minimum of 100-150 crop trees per acre (Martin and Gravatt, 1954; USDA, Forest Service, 1958). Fifty to 100 trees per acre is a bare minimum to allow for unmerchantability and/or mortality over a 60-70 year period.

2) Each white pine stand must be at least five acres in size. Previous minimum acreage for prunable white pine stands was 10-20 acres (Brown, 1971). However, according to Lake States blister rust personnel, many small ownerships have stands in the 5-10 acre range.

3) Minimum annual lethal white pine infection (based on the last five readable years when possible, i.e., except in stands younger than eight years) must be one percent or more, according to the following table:

White Pine/Acre	Minimum Annual Lethal Infection
200-299	1%
300-399	2%
400-499	3%
500-599	4%
600-649	5%
650-699	6%
700-749	7%
750-799	8%
800-849	9%
850 or more	10%

This table allows for more loss from blister rust in heavily stocked stands, and decreasing losses as the stand density decreases. It also allows for an above minimum number of final crop trees when pruning is not justified. As a hypothetical example: if a 10 year old stand had 850 white pine and a 9.99 percent annual infection over the last five readable years, all the infected trees died, and each five year period thereafter the annual infection was 0.01 percent less than the justifiable rate, and all infected trees died - at age 70 there would still be more than 180 white pine. Such a situation in nature would be unlikely; instead the annual infection would usually be less, with fewer trees lost, or more, justifying pruning and thus reducing the number of infected trees.

The above example does not provide for the natural death of the blister rust fungus itself before it reaches the trunk. Results of a study in the western states show that 24 percent of lethal cankers become inactive before reaching the trunk (USDA, Forest Service, 1970). King (1958) states that "In heavy stands infected lower branches and needles frequently die and slough off, thus removing the infection before it can reach the trunk." Results of another study show that, based on five years observation, nine percent of branch infections on 25 to 35 year old trees died. Also, based on a limited number of observations, 30 percent of infected branches smaller than 0.5 inches diameter on 25 to 35 year old trees died before the infection reached the trunk (Phelps and Weber, 1969). These results indicate that the number of white

pine killed by blister rust will normally be less than the number of trees with lethal infections.

Using another hypothetical example: if a 10 year old 280 tree per acre stand had 4 percent infection over the five year readable period; i.e., less than the rate that justified pruning, and continued to have 4 percent infection after each 5 year period with all infected trees dying, then 170 trees would remain at age 70. This assumes that the proportion of white pine fatally infected continues at a constant rate throughout the stand rotation. Literature cited under guideline No. 6 (Van Arsdel, 1961a; USDA, Forest Service, 1970; Weber, 1964b), which indicates that most infection occurs within a few feet of the ground, does not substantiate this suggestion. Data from literature cited under guideline No. 8 (Brown, 1971; Phelps and Weber, 1969) also indicates that most infections are within 6-8 feet of the ground, not above 10 feet, as would normally be the case with trees 40 years old or more.

Several blister rust control personnel (Brown, 1971) believe that 70 percent of all lethal infections occur by the time the trees are 20 years old, and that 90 percent occur during the first 40 years. Van Arsdel (personal communication, May 8, 1972) believes that 80 percent of all lethal infections occur by the time the trees are 20 years old, and 90 percent during the first 40 years. Thus, based on the above data and opinions, it is probable that few lethal infections will occur on white pine older than 40 years.

4) Annual infection rate (percentage) will be based on the number of trees with lethal infections, not the total number of lethal or all infections. Therefore, only live infections between 4-18 inches from the trunk will be considered in computing the infection rate and only one infection per tree is to be counted.

The four inch minimum means that the visible leading edge of the infection is no closer than four inches to the trunk; the 18 inch maximum means that the center of the infection is no farther than 18 inches from the trunk.

In the past, Lake States blister rust control personnel have been using a 4-18 inch lethal infection zone (Brown, 1971). Martin and Gravatt (1942, 1954) recommend the 4 inch minimum; King (1958) used a five inch

minimum in his blister rust incidence survey. Patty (1956) states that sugar pine limbs infected with blister rust can be removed and the tree saved from destruction provided that the growing end of the infection is six inches or more from the trunk. Results of a study by Stewart (1957) show that, after six years, no trees were infected where limbs with infections six inches or more away were removed. Branches with infections four to six inches from the trunk were removed, along with some bark around the branch stub, and none of the trees became infected. It is possible that the bark removal was unnecessary.

5) The first infection survey should be made as soon as the average white pine age is four years and the average white pine height is two feet. These stand combinations will not often occur the same year, e.g., plantation white pine are sometimes more than two feet tall when age four is reached, and natural stand white pine are frequently older than four years when the height of two feet is reached. It would be impractical to survey each stand the year the above height-age combination is attained; however, the first survey should not be more than two to three years later than this schedule.

The minimum four year age is to allow blister rust infection to become readable. A study by Honey (1941) shows that seven percent of blister rust cankers are recognizable after one year, 16 percent after two years, 45 percent after three years, 83 percent after five years and 99 percent after seven years. Ninety-four percent of blister rust infections on western white pine and 95 percent on sugar pine were readable after three years, based on data from over 7000 cankers (Kimmey, 1954). A four year incubation period was allowed before cankers were counted in a Minnesota survey (King, 1958). Boyce (1961) states that the infected bark assumes a yellow to orange color during the second season following infection, and on seedlings the discoloration often appears the season following infection of the needles. In a laboratory study by Van Arsdel (1968b), four year old white pine were inoculated with C. ribicola; 36 inoculations were made on old (one year) needles and 36 on new needles. All infections were apparent on the "new needle" seedlings within three years after inoculations. Ninety-five percent of the infections on the "old needle" seedlings were apparent after three years. It is probable that the minimum four year age in this guideline will allow the majority of two years infection

to be detected.

The minimum two foot height is based primarily on research by Van Arsdel and Weber. Van Arsdel (1961a) suggests that the microclimate of the lower branches is most favorable for blister rust infection. The same opinion is expressed in literature relating to the western states (USDA, Forest Service, 1970). Data from 10 foot high trees in a Wisconsin pruning study show that 86 percent (152 trees) of the fatal infections were one foot or less high. In this study, of 65 trees killed by blister rust during the first 10 years after planting, none died the first three years, one died the fourth year, 11 had died through the fifth year, and 30, almost half, had died through the sixth year (Weber, 1964b). Seventy-four percent of 254 fatal infections on 24 foot tall white pine on the Nicolet National Forest were four feet or less from the ground (Weber, 1964b). This data strongly indicates the need for early pruning of white pine to obtain the best control results.

6) The maximum number of selected crop trees per acre pruned will be 200 for natural stands and 350 for plantations. Ritter (1955) recommends pruning 150-200 white pine per acre where blister rust is a problem; McCulley (1953) recommends pruning 100-200 white pine per acre where blister rust is present. Two hundred white pine per acre were pruned on the Nicolet National Forest pruning plots (Weber, 1964b). Putnam (1956) recommends pruning 200-250 selected crop trees per acre for blister rust control. Without regard to blister rust, Hawley and Clapp (1935) recommended pruning 150-200 pine per acre in plantations; Ehly (1958) recommends pruning 150-200 pine per acre in plantations. The number of trees has been increased in this guideline to allow for greater selectivity of crop trees in the stand prior to final harvest.

7) White pine should be pruned to 50 percent of the total tree height, or nine feet, whichever is less. Results of the Lake States pruning evaluation (Brown, 1971) show that 76 percent of 611 blister rust infections were from 0-6 feet and 90 percent were from 0-9 feet above the ground. Ninety-four percent of 400 trunk infections were less than eight feet above ground (Phelps and Weber, 1969). In a 26 year old, 24 foot tall white pine plantation plot, 188 first fatal infections were 0-4 feet, 238 were 0-6 feet, 254 were 0-8 feet and none were more than eight feet above the ground, (Weber, 1964b, 1972). Van Arsdel (1961b) estimates that 99 percent of all blister rust cankers in the Lake States are within six feet of the ground.

Probably the nine foot maximum pruning height in this guideline will seldom be used, except for unpruned stands that are presently near 18 feet tall. The research data cited here and under guideline No. 6 indicates that few stands will need to be pruned above four or possibly six feet.

8) All limbs with lethal infections above the normal pruning height that are easily accessible, should be pruned. Besides eliminating potentially fatal infections outside the prescribed pruning height, this action will also reduce the need for a future pruning.

These guidelines have been prepared primarily for timber production purposes. Although white pine obviously has a scenic value in the Lake States, data relating to the effects of blister rust on this value are not available. Probably, the above guidelines will satisfactorily preserve the scenic value of most stands. It is doubtful that the average aesthete is concerned if a pure white pine stand has 1000 or 500 trees per acre, or 200 instead of 400. Also, it is probable that most aesthetes would be as pleased if a timber stand had 300 aspen or birch and 100 white pine, as if the stand had 400 white pine. Certainly some persons are annoyed at a blister rust "flag" or a tree killed by blister rust; but there are others who think nature (which includes blister rust infection) should be allowed to take its course.

There will be a few white pine stands, or isolated white pine, that do not meet the above requirements for pruning, and yet should be pruned for aesthetic reasons. In such cases, if federal funds are requested, a project proposal fully describing each situation should be submitted.

GLOSSARY

1. "Saved" white pine - a white pine rendered non-infected by removal of one or more lethal blister rust infections.

2. Fatal blister rust infection - a live blister rust infection which has infected the main bole of the tree.

3. Lethal blister rust infection - a live blister rust infection which has not infected the main bole of the tree, but probably will in time.

4. Non-lethal blister rust infection - a live blister rust infection which probably will not infect the main bole of the tree.

5. Healthy white pine - a white pine with no blister rust infection.

6. Prunable white pine - a white pine with no fatal blister rust infection.

7. Non-prunable white pine - a white pine with one or more fatal blister rust infections.

8. Readable years - successive years of annual growth on white pine in which a blister rust infection can be detected. The first readable year for each infection is the year of annual growth on which the infection is first apparent.

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